Big Creek Fish Passage Project (Roughened Channel at Ensign Ranch) Preliminary Design Report

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Big Creek Fish Passage Project
(Roughened Channel at Ensign Ranch)

Preliminary Design Report

1. Introduction and Background

A substantial barrier to upstream fish passage exists in Big Creek only ¼-mile above its confluence with the Yakima River, 8 miles west of Cle Elum, Washington (Figure 1). It is presumed that all fish species in the Yakima River would use Big Creek if they were able. However, an existing concrete sill barrier would stop all juvenile fish access into Big Creek, and would also stop all adult fish except coho salmon and steelhead. There are about 20 miles of stream habitat above the subject barrier, and all upstream aquatic habitat appears to be in good to excellent condition for fish production. Resident and anadromous fish communities would significantly and immediately benefit from correction of this fish passage barrier.

The barrier is a thick concrete slab extending all across Big Creek, with a vertical water level drop of about 3' into a large plunge pool. It is presumed that one purpose of the concrete slab is to protect shallow concrete footings from being under-mined for a 100'-span steel bridge over the creek. The concrete slab also maintains an elevated water surface for a screened diversion of up to 1.7 cubic feet per second (cfs) into a small canal serving multiple purposes on the Ensign Ranch.

The Yakama Indian Nation (YIN) proposes to build a roughened channel at the subject site, to allow unrestricted upstream and downstream fish passage for all native fish species, and all fish life-stages, into (or out of) Big Creek. Anadromous fish expected to benefit from the project would include chinook salmon, coho salmon, steelhead, and Pacific lamprey; resident fish species including rainbow trout, sculpin, and suckers would also gain substantial habitat after the project.

Major elements of the proposed roughened channel project for fish passage (upstream and downstream) will include the following (see drawings):

- ✓ Construction of a 120'-long roughened channel, with bottom width 45' to 95', to provide year-round fish passage at all flows except peak floods. On-site, the channel will span from the existing concrete sill under the bridge to 120' downstream.
- ✓ Streambed armor layer materials for the channel bed and banks would include angular rock (basalt from a surface mine), or rounded boulders (if locally available), from 24" to 48"-size with a random assortment of sizes spanning this range. Small gravel and sand from an alluvial deposit (gravel pit), either "pit-run" or specifically mixed for this project, would fill voids between large rocks to prevent Big Creek from becoming subsurface through the roughened channel reach.

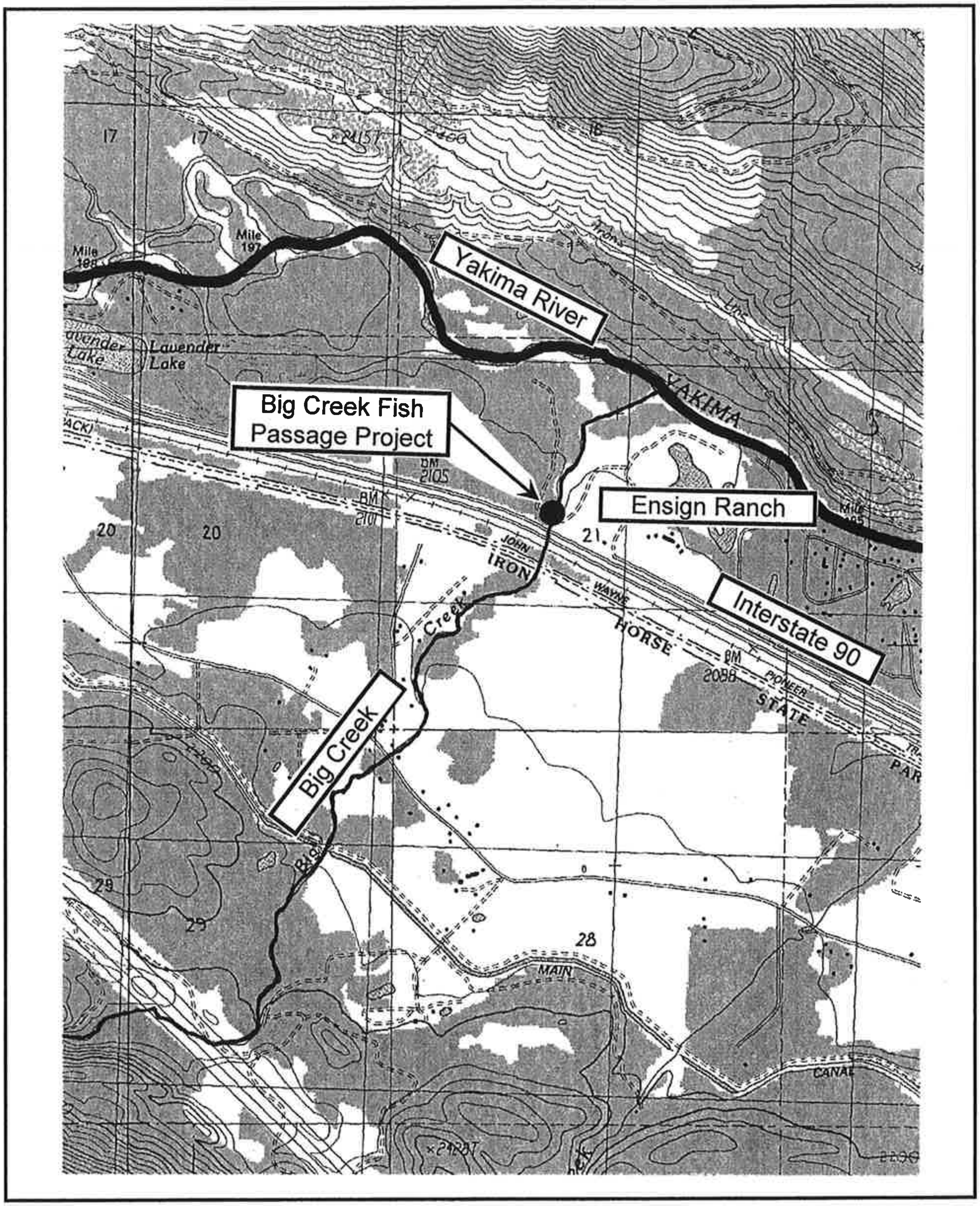

Figure 1. Big Creek Fish Passage Project location near the stream's confluence with the Yakima River. The site is about 8 miles west of Cle Elum, Washington, within the LDS' Ensign Ranch (in NW¼, Section 1, T20N, R14E). Map scale: 1" = 2,000'. Map source: DeLorme 1999.

- ✓ The existing steel bridge, which functions well for the Ensign Ranch operated by the Church of Christ of Latter-Day Saints (LDS), would not be affected by the fish passage project. A horse trail about 250' downstream of the bridge, which crosses Big Creek, would remain unchanged after the project.

Permit applications for channel construction will be started soon after distribution and review (by all entities) of this preliminary design report. The channel preliminary design (see drawings) is considered suitable for development of all required permit applications, and review by regulatory agencies (local, state, federal, tribal). Required permits will include a Hydraulic Project Approval from the Washington Department of Fish & Wildlife initiated through the Joint Aquatic Resources Permit Application (JARPA), using the Streamlined Process for Fish Habitat Enhancement Projects. A permit from the U.S. Army Corps of Engineers (Corps) will be needed, integrated with the JARPA process, and possibly taking advantage of Nationwide Permit authority and/or programmatic consultations (with NMFS, USFWS, Indian Tribes, etc.) the Corps has completed for the removal of fish passage barriers.

Construction of the roughened channel is scheduled to be completed by the end of October 2014 contingent on accomplishment of the following tasks, with time deadlines listed in parentheses.

- ➢ Completion of preliminary design report (this report), and preliminary design drawings (early April 2014).

- ➢ Inter-agency review, evaluation, design suggestions, consultations, etc. with and by the LDS Ensign Ranch, WDFW, Yakama Indian Nation, Kittitas County, NMFS, and/or others for refinement of the overall project proposed in this report. It is recognized that multiple entities will need to support the preliminary design of the fish passage project, to allow final design and construction to proceed (reviews to be done by mid April 2014).

- ➢ Efficient and expeditious processes for required construction permits for the roughened channel, which will be a substantial fisheries resource improvement for this tributary to the Yakima River (permits to be obtained by mid June 2014 to precede award of construction contract).

- ➢ Final design for roughened channel construction and associated site work. Development of construction contract documents to be competitively bid by private general contractors (construction contract documents to be done by early May 2014).

- ➢ Inter-agency review of final design and construction documents (reviews done by mid May 2014).

- Construction contract advertisement and bidding late May thru mid June 2014. (selection of contractor by end of June 2014).

- Project mobilization by early September, with construction completed by end of October 2014.

In the interdisciplinary profession of fisheries engineering, design techniques for roughened channels have significantly advanced over the last 20 years. Experience and progress have been gained for roughened channel design, and WDFW (2013) has substantially revised their recommendations from an earlier publication (WDFW 2003) which stated, "roughened channels are viewed as experimental at this time." In the new Water Crossing Design Guidelines (WDFW 2013), roughened channel design is presented as a tried-and-true method for providing fish passage, and the proposed channel for Big Creek would be within technical guidelines presented in WDFW (2013).

The design engineer for the Big Creek channel (Paul Tappel, Civil Engineer & Fisheries Biologist) has designed about 60 roughened channels within the State of Washington in the last 15 years; all have been built and appear to provide excellent fish passage. Also, these roughened channels have remained in-place and have functioned as-designed as long as 15 years, during which time some channels have experienced peak flow events of long recurrence interval (50-year to 200-year events). This experience provides substantial confidence that the proposed roughened channel for Big Creek would be an excellent fish passage channel for the subject site; the channel would also pass flood flows, low flows, large wood, bedload, and everything else in a near-natural manner. A summary of the designer's track-record (Fisheries Engineers 2012) shows that the proposed roughened channel for Big Creek would be in the approximate middle of as-built channels, with respect to channel slope (Figure 2).

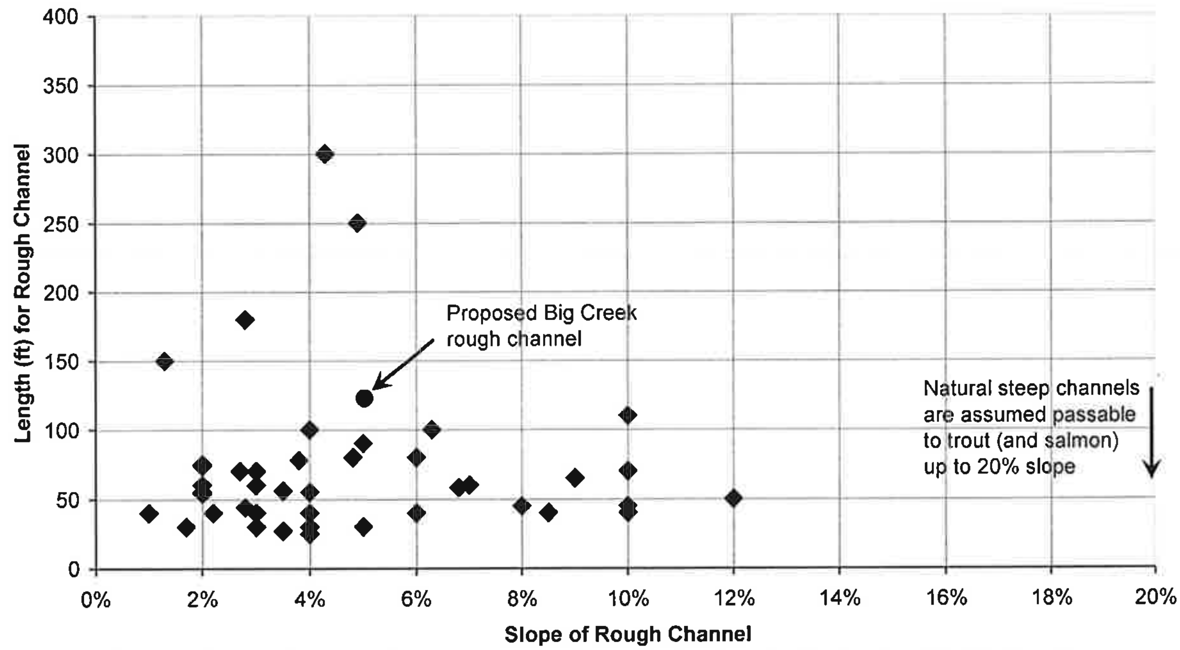

Figure 2. Slope and length data for rough channels designed and built in Washington (1998-2011). All channels (n = 44) appear to provide very good upstream fish passage (for all native fish species). The channels have all withstood high flow events; some channels have been through 50-year to 200-year floods without mobilization of the constructed armor layer (rough channel). More channels have been designed and built since 2011, but the graph has not been updated.

2. Design Criteria

Design of fish passage projects (including roughened channels) requires an interdisciplinary application of fish passage knowledge, practical experience, civil engineering calculations, hydrologic and hydraulic evaluations, consideration of multiple criteria, incorporation of perceived requirements for construction permits, and common sense. It is impractical to list all criteria used for roughened channel designs; however, some of the most important technical criteria are listed below for each category:

<u>Fish Passage Criteria</u>

- Channel design should mimic nearby stream reaches (cross-section dimensions, streambed variability, etc.) that are in undisturbed natural conditions (NMFS 2008, WDFW 2003).
- According to NMFS (2008), channel slope should be less than 6% and length less than 150'; the Big Creek channel would meet these criteria. The design engineer thinks these criteria are too conservative, and WDFW (2013) guidelines would support

channels up to 20% slope if energy dissipation factor (EDF) at the high fish passage flow was within a certain range.

- Channel construction should result in a low flow depth = 1' or more (NMFS 2008). This low-flow channel should meander through the roughened channel length (WDFW 2003).
- Voids between boulders or large rocks should be minimized with placement of finer-grained streambed materials (NMFS 2008, WDFW 2013).
- Do not include discrete hydraulic drops, for example rock weirs, within the roughened channel design (NMFS 2008).

Engineering Criteria

- Roughened channel streambed and bank armor layer materials should be sized to be stable at the peak design flow, at least the estimated 100-year flood (WDFW 2013).
- Energy Dissipation Factor (EDF) should be less than 12.5 $ft*lb/ft^3/sec$ for a 5% slope channel (WDFW 2013), as a measure of turbulence and hydraulic energy dissipation.
- Streambed slopes along the roughened channel shall not be steeper than 2:1, except as required to meet existing steep banks under and/or near the existing bridge.
- Armor layer materials shall extend across the entire roughened channel width, and up banks at least as high as the estimated 100-year flood levels.

Requirements for Permits

- Clearing of riparian vegetation along Big Creek shall be minimized to the areas required for channel construction. Except for a small grove of small-diameter alder on the east bank (for site access), clearing would be limited to the west bank of Big Creek (see drawings).
- Construction work shall be isolated from any flowing water to minimize downstream turbidity.
- Final drawdown of standing water in the project area shall be accompanied by gradual pumping, combined with careful fish removal (with small hand nets) from isolated creek pools. All captured fish shall be held in plastic buckets with creek water, and quickly released to the Yakima River downstream.

- Project design shall directly and indirectly incorporate normal requirements associated with a Hydraulic Project Approval (WDFW) for projects of this type.

- Some entity (LDS, Yakama Nation, WDFW, ?) shall commit to long-term monitoring of the roughened channel for fish passage function and structural durability (NMFS 2008, WDFW 2013). Technically, the roughened channel would be considered a fishway (WDFW 2013), and guidelines for development of an inspection plan are included in this reference.

3. Site Survey

In February 2014, survey data were collected on-site by the design engineer and Yakama Indian Nation. This survey collected detailed information on site topography, channel elevations, bridge dimensions and alignment, etc. using a total station survey instrument (Leica TC800), with the survey focused on water and land areas considered most important for roughened channel design. Survey data were used to develop the project's base map (overhead view), and were also used to draw cross-section and profile drawings for roughened channel design. The site survey covered an area of ¾-acre, including a stream channel length of 320'.

4. Big Creek Design Flows & Channel Rating Curves

Flow Estimates for Design

Flow estimates most useful for fish passage design include a "low fish passage flow", "high fish passage flow", and flood flows. The low fish passage flow was estimated using methods presented by WDFW (1994), which are based on a regional evaluation of 60-day low flows in gaged creeks. The low fish passage flow for Big Creek was estimated to be 3 cubic feet per second (cfs). Quantitative methods for estimating high fish passage flows are not known for eastern Washington; therefore, this flow was assumed to be 50 cfs for Big Creek, which would be a small fraction of the estimated 100-year flood.

Flood flows were initially estimated using equations based on regression analyses for eastern Washington streams, as presented by Sumioka et. al. (1998); the estimated 100-year flood was 870 cfs per this reference. Brent Renfrow (2014) considered this peak flow estimate, vs. his long-term experience with Big Creek, and advised that this flow estimate was likely too low:

- The point estimate (870 cfs) based on USGS' regression equation did not account for statistical variability in the data. One standard error would result in a 100-year flood estimate = 1,400 cfs.

- For design of the I-90 concrete bridges just upstream of the project site, WSDOT determined a 100-year flood = 3,140 cfs.

Based on the data provided by Renfrow (2014), the 100-year flood flow estimate was assumed to be about 2,000 cfs for rough channel design. The proven durability of rough channels built with the engineer's designs would provide substantial confidence that the constructed channel would remain long-term, even if the 100-year flood flow estimate was moderately incorrect. In fact, a 100-year flood = 3,000 cfs would not change the subject design.

Flow Rating Curves and Hydraulic Data

Flow rating curves were developed for Big Creek at the project location using Manning's equation (Chow 1959) combined with site survey data for the existing stream channel, and design dimensions for the proposed rough channel (Figure 3). The rating curve for the existing channel was developed for a composite stream channel that would have dimensions more-or-less the same as the downstream half of the proposed rough channel (e.g. 45'-wide main flow channel), and at the existing stream channel slope = 1%. The rating curve for the proposed rough channel was based on channel dimensions for the downstream half of the channel (45'-wide main flow channel) at 5% slope.

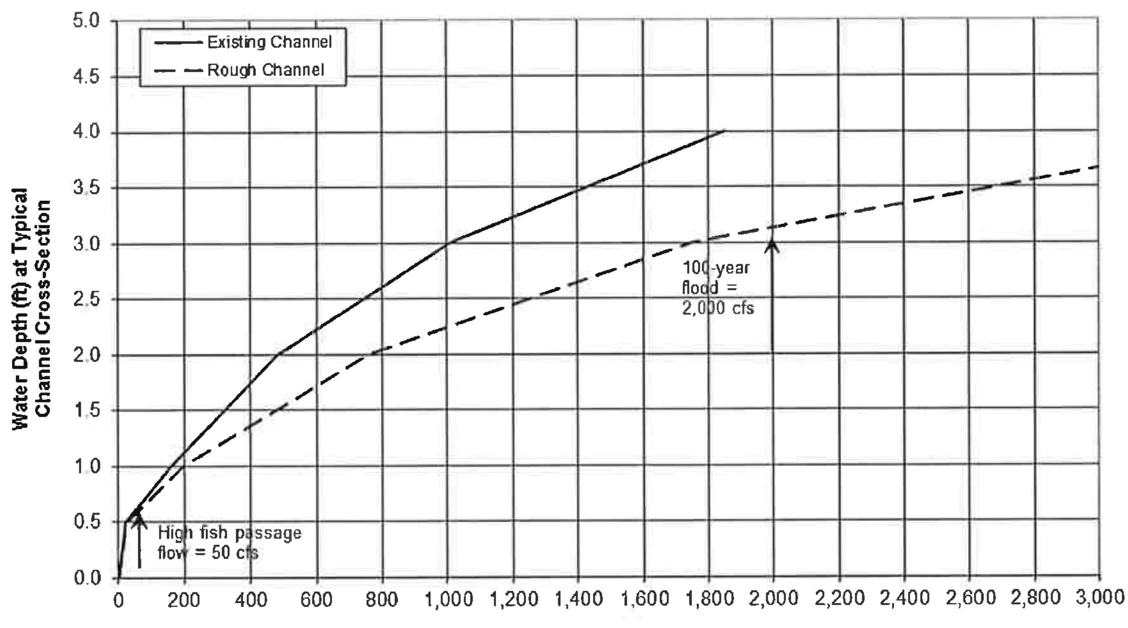

Figure 3. Rating curves for existing Big Creek channel (1% slope) vs. proposed rough channel (5% slope) for downstream of existing Ensign Ranch bridge. The rating curve shown for rough channel would apply to the downstream half; the upstream half widens to span the entire bridge crossing and flow depths would be lower (see drawings).

For the low fish passage flow (3 cfs), water depth would be less than 0.5' (at stream center) and average water velocity would be less than 1 foot per second (fps), for the existing creek channel and proposed rough channel. The stream would be physically passable to small fish at this low flow, but it is believed that fish would have few incentives to migrate upstream at this low flow rate. It is recognized that the 1' depth criterion recommended by NMFS (2008) would not be met at the low fish passage flow, for either the natural stream channel or constructed rough channel.

The high fish passage flow (50 cfs) would result in a flow ranging from 0.5' to 1' deep (Figure 3) with moderate velocity (3 fps +/-). At this flow, the relatively high roughness factor (Manning's n-value) for the rough channel would keep water velocity and depth about the same as the existing channel, even though the rough channel would be steeper (5% slope vs. 1%). Hydraulic conditions would be suitable for upstream (or downstream) fish passage for all native fish species in the flow range between low fish passage flow and high fish passage flow.

A 100-year flood (2,000 cfs) would have water depth averaging 3' for the rough channel, and about 4' for the existing stream channel (Figure 3). During peak flow conditions, there would be an acceleration of water velocities from averages of 9 fps within the existing channel to about 12 fps within the proposed rough channel. This flow acceleration would occur just upstream of the rough channel (i.e. under the existing bridge) and there would be a 0.5' drop (+/-) in water surface elevation due to the flow acceleration (i.e. velocity head). Peak flows down the roughened channel would be turbulent, with variable velocities and depths including standing waves and whitecaps. There would be a moderate backwater effect experienced by peak flows over the bottom $^1/_3$ to ½ of the proposed roughened channel; the downstream 40' reach of the channel would be countersunk below the existing streambed (see drawings).

Energy dissipation factor (EDF) at the high fish passage flow was estimated to be 11 ft*lb/ft^3/s, which would be within general guidelines presented by WDFW (2013) for roughened channel design. Overall with respect to hydraulic design, the proposed rough channel should work very well for multiple decades for fish passage, flood flow conveyance, transport of large floating wood, bedload movement, and other stream functions.

5. Preliminary Design for Roughened Channel

<u>End Elevations, Gradient and Length for Roughened Channel</u>

Channel gradient (slope) is one of the key variables that determines whether or not a roughened channel will function long-term for the intended fish passage objectives; the other most important variables are the channel cross-section dimensions and the size of streambed armor rock for channel stability. This report section explains how upstream and downstream channel elevations were determined, how the roughened channel gradient was selected, and how the proposed channel length was established.

Design commenced with an assumption that the existing concrete sill (top elevation 2074.7') would remain in place to protect existing bridge footings, and also to provide sufficient water depth at the existing irrigation water intake just upstream. The proposed roughened channel would need to have an upstream bottom elevation (thalweg) equal to the concrete sill top elevation.

Selection of the rough channel gradient was partly subjective, and the design engineer considered any slope 2% to 8% to be within reason for the subject site; the existing stream gradient below the concrete sill is about 1%. In an AutoCAD profile drawing, different channel gradients were superimposed over the existing channel slope. A 2% gradient rough channel would need to be more than 300'-long to intersect the existing channel profile; this was considered excessive length. A channel of 8% slope would seem steeper than required on-site, although the relatively short length (50') would minimize construction costs. Given site conditions and considering previous experience, a rough channel with 5% slope was considered a reasonable choice; the rough channel would intersect the existing stream 80' downstream of the concrete still, and this gradient would more-or-less be in the mid-range of other successful rough channel designs by the engineer (see Figure 2).

Cobble, gravel and sand alluvial materials downstream of the existing concrete sill do not appear to form a solid armor layer for the streambed. Instead, these stream bottom materials appear to be subject to mobilization during peak flow events, with likely transport downstream to the Yakima River. There are no obvious signs on-site of channel aggradation (building up by bedload deposition) or incision (channel scour to lower elevation), except the large and deep plunge pool just below the perched concrete sill. These observations show there is no stable "downstream control" (for hydraulic and streambed design) and it would therefore be reasonable to countersink the proposed rough channel into the downstream channel bed. The depth of countersink for channel design is no more than an "educated guess" of the depth that future channel incision could drop the stream channel over some period of decades.

For previous projects, the design engineer has included countersunk channels (downstream end) as a safeguard against possible erosion of existing streambeds, with a depth of countersink normally 1' to 2'. The proposed length to construct the Big Creek rough channel (120') would result in a 1.5'-deep burial of the downstream end of the channel (Drawing 3). Big Creek downstream of the proposed rough channel appears relatively stable for elevation (neither aggrading or incising), and the Yakima River is a short distance downstream. The likelihood of substantial channel incision (>1.5') was considered low.

Roughened channel elevations, gradient, and length are proposed as follows:

- ✓ Upstream elevation 2074.7', which is the top elevation of the existing concrete sill. During very low creek flows, the narrow low flow channel at upstream end will create a 6"-deep (+/-) backwater over the concrete sill (see Drawing 4).

- ✓ Downstream elevation 2068.7'. This downstream elevation will be about 1.5' lower than existing streambed elevation (Drawing 3).
- ✓ Overall channel length = 120'; however, it is expected that the downstream 40'-long reach will be buried by native streambed materials.
- ✓ Proposed channel gradient = 5.0%.

Cross-Section Dimensions for Roughened Channel

An important design criterion for roughened channels is that roughened channel cross-section(s) should be approximately equal in dimensions to nearby natural stream channel sections (NMFS 2008, WDFW 2013). This design guideline was applied to the Big Creek location as follows.

Several stream cross-sections surveyed downstream of the existing concrete sill (unaffected by the concrete sill) were combined into a composite stream cross-section; this section had a channel width = 45', and about 1.5' gain in elevation from thalweg (lowest point in channel) to edges of main channel. Existing streambank slopes were variable, but an overall 2:1 slope (horizontal:vertical) would be generically representative. These channel dimensions were used for design of the downstream end of the proposed rough channel (see Sta. 0+00, Drawing 4), with this dimension extended upstream for the channel design.

The LDS Ensign Ranch's existing bridge over Big Creek spans a total 100', with one intermediate pier (Drawings 1 and 4). It is unknown why the bridge is 100'-long, since the existing channel and flow routing indicate that the estimated 100-year flood (and debris) could readily pass underneath a bridge about 70'-span. Two alternative alignments for the proposed rough channel were considered: 1) Extend 45'-wide main channel from the downstream end up to the existing concrete sill, and leave the space between mid-channel pier and west abutment hydraulically disconnected; or 2) Gradually increase rough channel width in an upstream direction, to fully span the existing concrete sill 95'-wide (+/-) at the bridge.

A substantial consideration for selection of the second alternative (expand the channel width to 95' at upstream end) was as follows. If the west portion of bridge (concrete sill) was left out of the rough channel, there would be an armored channel downstream of the east $^2/_3$ of the crossing, and native alluvial deposits downstream of the west $^1/_3$. A flood large enough to surge thru the west channel under the bridge may be capable of mobilizing and transporting these materials, and the main creek channel could avulse (change channel) to the west of the constructed rough channel. Although considered unlikely, the result of this channel avulsion would be creation of a new fish passage barrier in the west portion of creek, similar to the existing 3'-drop at concrete sill.

Proposed channel cross-section dimensions are on Drawings 3 and 4, at 30' increments (+/-) from the downstream end of the channel. Station 0+00 on the drawings is at the downstream end of the rough channel, Sta. 0+30 is 30' upstream, etc. The proposed channel bottom would gradually increase from 45'-wide at Sta. 0+00, to 95'-wide just downstream of the existing bridge.

Streambed and Streambank Materials for Roughened Channel

Streambed and streambank materials for the proposed Big Creek roughened channel would be 24" to 48" angular rocks (or boulders if locally available) placed in a 4'-deep layer from the concrete sill to 60' downstream, then the rock thickness would taper to 2'-thick at the downstream end channel (Drawing 3). The reduced armor layer thickness for the downstream channel reach coincides with a reduced likelihood of bed mobilization within or near the countersunk portion of the channel.

Voids between all large rocks would be filled with a gravel and sand mix (i.e. 2"-minus gravel and sand from an alluvial deposit). The large rocks would form a durable channel armor layer, and the finer-grained materials would minimize subsurface flow during low flow periods. The size range for the streambed armor layer, and the smaller grained alluvial materials to fill voids (see chart on Drawing 4), would result in a channel bed similar to previous successful roughened channel projects.

Determination of a good size range for armor layer materials for roughened channel construction is one of the most important design elements (NMFS 2008, WDFW 2013). These roughness elements (boulders or angular rock) are intended to remain stable through the peak flow for design; for Big Creek the peak design flow = 2,000 cfs (100-year flood). Mobilization of the armor layer would be immediately followed by erosion of whatever native materials lay underneath the roughened channel, and the stream would then headcut upstream to re-create a fish passage barrier like the existing barrier at the concrete sill.

The design engineer (author of this report) is well-aware of the quantitative methods suggested for roughened channel armor layer design by WDFW (2013). However, in the past, application of multiple methods for determination of armor layer materials has resulted in substantial variations for the recommended sizes of boulders or angular rocks for a specific project, and this has been an impractical result. Over the last 15 years more-or-less, the engineer has developed a systematic method for determination of armor layer sizes for roughened channels. Although this system is not entirely accountable with quantitative methods, the boulder or rock sizes determined through this method have been stable in multiple roughened channels for up to 15 years (i.e. all channels shown in Figure 2, and all channels constructed after Year 2011).

The rock-sizing method for roughened channel design includes consideration of channel slope, 100-year flood, estimated water depth and velocity at peak flows, flow rating curve, bedload mobilization, and other technical topics relevant to streambed stability. Application of the design engineer's method to the proposed roughened channel for Big Creek (at Ensign Ranch) resulted in a size range of 24" to 48" rocks (or boulders) for the armor layer (Figure 4).

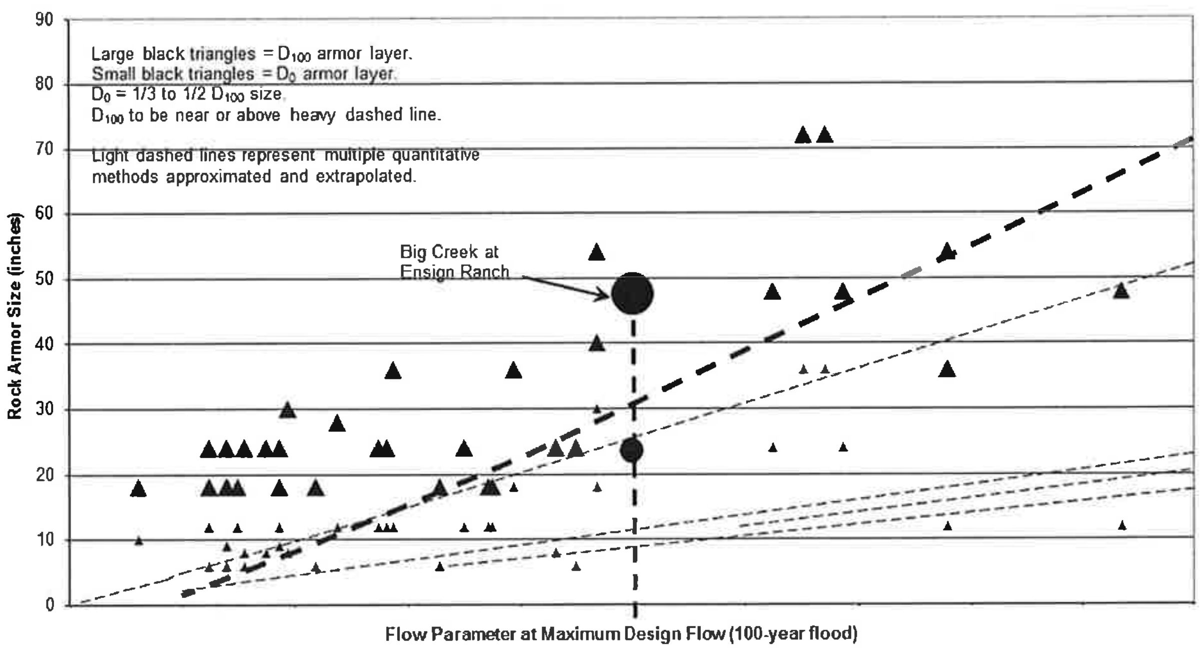

Figure 4. Sizes of armor rocks for roughened channels designed by Paul Tappel (1996-2010) vs. flow variable at 100-year flood, with the proposed Big Creek armor layer shown for comparison (black circles). Rough channel designs after 2010 would be similar to those shown (n = 60+ total channels). All constructed roughened channels are still functional after multiple high flows over the last 15 years, in some cases Q = 50-year to 200-year (?) events. Big Creek armor rocks would be 18" to 36"-size (+/-) in a 4'-thick layer.

The design engineer's confidence in the long-term durability of the proposed roughened channel bed (and banks) is supported by the following:

- ✓ Boulders or angular rocks 24" to 48"-size for Big Creek would be substantially larger than bedload particles in the streambed that appear mobile (existing cobbles, etc.).

- ✓ Specification for the range of boulder or large rock sizes was done consistently with methods the engineer has used for design of 60 +/- roughened channels in Washington. These channels have all been built at slopes of 1% to 12%; they have all remained in place as long as 15 years, and through some very high flow events in recent years.

- ✓ Riprap placed under the I-90 bridges just upstream appear to be stable, and these angular rocks have dimensions about 24" to 48"-size. Roughened channel materials placed in a large matt would be more stable than the sloped riprap placed by WSDOT.

- ✓ Gravel and sand to fill voids in the armor layer will be from alluvial materials sorted (or mined) for this project. Big Creek flows may remove some of these small-sized materials via venturi hydraulic effects (hydraulic suction caused by high velocities); however, Big Creek appears to have substantial bedload transport that would result in deposition of replacement materials to fill voids between rocks.

6. Site Preparation

Site preparation would include construction of a short channel access route from the existing road near the Big Creek bridge, and clearing of the west bank for channel excavation and construction. Drawing 1 includes details and notes for initial site work; it is recommended that readers of this preliminary design report make sure they have the 3-dimensional roughened channel clearly in their minds (i.e. Drawings 2 thru 4) prior to review of Drawing 1. The site preparation and work sequence requirements (Drawing 1) are based on multiple similar projects successfully accomplished for fish passage.

Local information indicates there is a good likelihood that Big Creek flow will be very low during September and early October; this is the recommended time for channel construction. Notes on Drawing 1 indicate how fish in isolated pools would be safely collected and transported downstream to the Yakima River prior to any in-channel construction work. If Big Creek has measurable flow during the construction project, additional measures would be developed to separate all construction work from any flowing water.

7. Existing Facilities and the Roughened Channel

Integral to the rough channel design would be zero effects on the existing Ensign Ranch infrastructure and/or operations:

- ➢ No changes to existing bridge or concrete sill across Big Creek.
- ➢ The existing road would remain the same near the bridge.
- ➢ No changes to the existing horse trail 250' downstream of the bridge.

8. Construction Quantities and Construction Cost Estimate

The preliminary design drawings and design notes, etc. were used to develop a list of construction items and material quantities for the roughened channel project, which cumulatively were used for estimation of the construction cost for the fish passage project (Figure 5). The estimated costs for "unit prices" listed on the Bid Form (Figure 5) are comparable to similar and recent roughened channel project construction experience in Washington; the total construction cost is estimated to be $121,000.

Figure 5. Big Creek Fish Passage Project Bid Form

Contractor: Engineer's Estimate **4/8/2014**

Spec.	Item	Qty	Unit	Unit Cost	Total Cost
1-09	Mobilization	1	LS	$6,300	$6,300
1-50	Surveying	1	LS	400	400
2-01	Clearing and Grubbing (on-site disposal)	1	LS	2,400	2,400
2-01	Temporary Culvert (access route)	1	LS	600	600
2-09	Excavation (store streambed as needed)	950	CY	12	11,400
2-09	Backfill w/ Native Streambed Materials	280	CY	8	2,240
2-09	Backfill w/ Native Soils (channel edges)	80	CY	6	480
2-09	Haul & Dispose Excess Soils (on-site)	590	CY	8	4,720
2-20	Water Pumping & Control (pool drawdown)	1	LS	600	600
8-30	Erosion Control Seed	5	LB	10	50
8-40	Straw Mulch	12	BALE	20	240
9-13	Large Rocks (24" to 48"-size)	1,580	TN	40	63,200
9-40	Gravel & Sand Mix (2"-minus)	640	TN	30	19,200
Construction Subtotal (without sales tax):					$111,830
Washington State Sales Tax (@ 8.0%):					$8,946
Total Construction Cost (rounded):					$121,000

CY = cubic yard
EA = each
LB = pound
LS = lump sum
TN = ton

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